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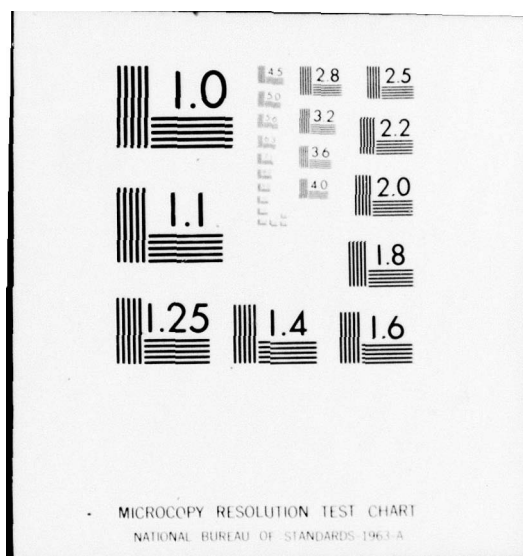
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ENGINEERING AND SCIENTIFIC RESEARCH AT WES



Miscellaneous Paper 0-74-3

May 1974

PARB SHOCK AND VIBRATION LEVELS,

by T. E. Kennedy,

Weapons Effects Laboratory

The Safeguard Perimeter Acquisition Radar Building (PARB) is one of the largest aboveground hardened structures ever constructed (fig. 1). It contains a phased-array radar which provides long-range search, detection, target selection, and tracking functions for the Safeguard System. The PARB is required to survive and function during, as well as prior to and after, a nuclear attack and will experience high-frequency interior vibrations. Current analysis techniques preclude reliable prediction of these high-frequency interior vibrations.

In order to obtain more information on the in-structure shock loads, a 1/12-scale reinforced concrete model of the PARB (fig. 2) was tested during Event Dial Pack, a 500-ton TNT detonation conducted by the Defense Nuclear Agency in July 1970. The model was subjected to the combined effects of airblast and ground shock loadings. Airblast was measured on all faces of the structure and acceleration and velocity were measured within the structure. Analysis of the data revealed higher levels of

vibration than computer design analyses were capable of predicting.

Unfortunately, the Dial Pack data did not provide a large statistical sample and scaling up to the prototype was clouded by differences in geology between the two sites and by uncertainties in scaling the higher frequencies in the test data. Because of these uncertainties, additional test data were sought to aid in application of the Dial Pack model data and a series of vibration/impedance tests was conducted on both the model and prototype. Because the PARB is designed to remain elastic, it was possible to use the vibration data and linear theory to obtain impedance and transfer functions for various paths in the model and prototype. This process is shown diagrammatically in fig. 3. Convolution of the airblast data from Dial Pack with measured impedances from the model provided estimates of vibration levels in the model which compared favorably with measured data from the Dial Pack test. Using the knowledge gained from the model study and the vibration data from the prototype, impedance functions for the prototype were developed.

The test series conducted on the 1/12-scale model and the prototype PARB consisted of driving points on the

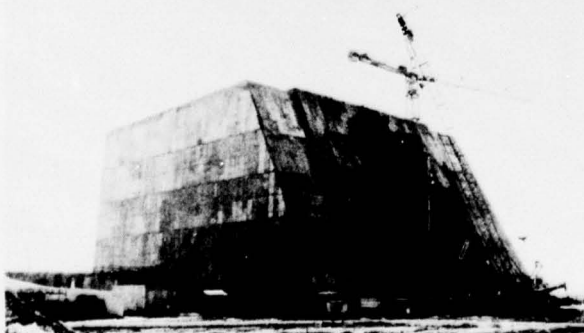


Fig. 1. Prototype PARB under construction

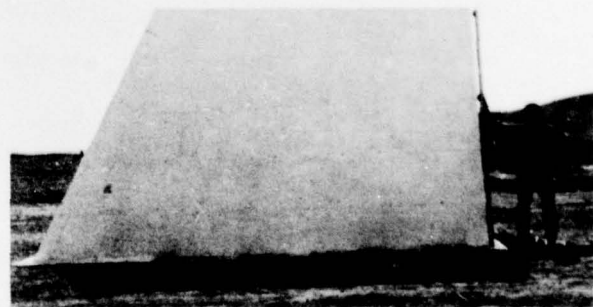


Fig. 2. Completed 1/12-scale Dial Pack model PARB

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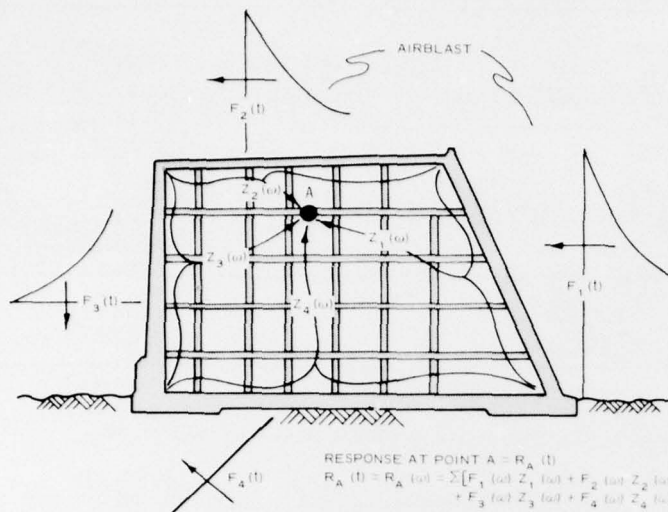


Fig. 3. Diagrammatic loading and transmission paths for a response at point A

inside and outside of both structures using mechanical vibrators. The vibrators' force output was held constant while the frequency was varied over the range of interest. Fig. 4 shows the 5000-lb vibrator used to vibrate the prototype PARB.

Fig. 5 shows typical mechanical impedance data taken on the prototype. These data were taken by driving the roof center and measuring the output on the center of the fifth floor and then reversing the driver and gage locations.

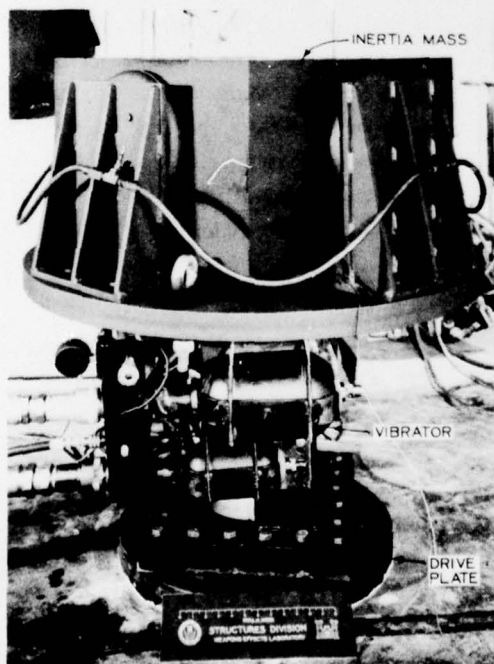
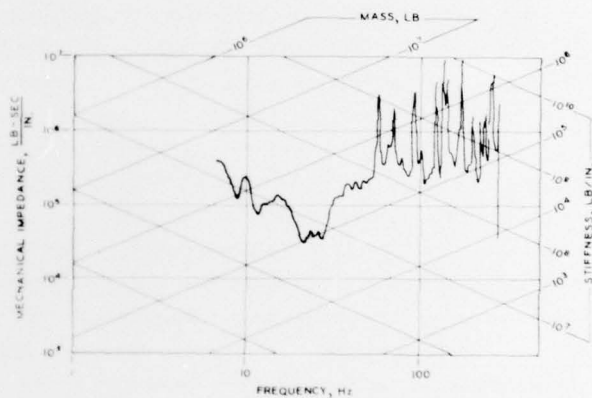
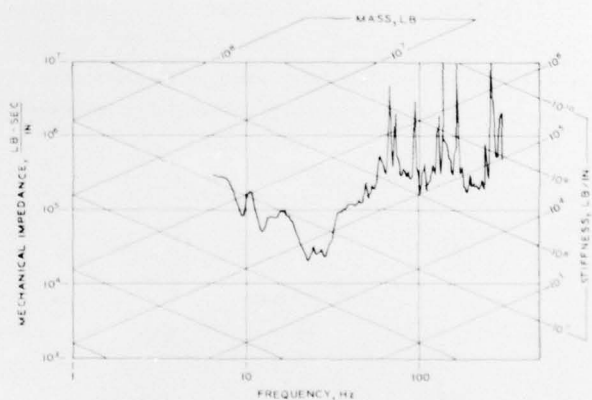


Fig. 4. 5000-lb electrohydraulic vibrator mounted inside the prototype PARB



a. Drive point, roof center; measurement point, fifth floor center



b. Drive point, fifth floor center; measurement point, roof center

Fig. 5. Prototype PARB data (5000-lb driver force)

Note the almost peak-for-peak correlation between the functions, indicating excellent reciprocity (linearity).

To date it has been possible to drive individual areas of the roof of the model using the Dial Pack airblast as input and hence to predict the resulting motion at a given point inside the structure. Fig. 6a shows the velocity-time history computed for the inside of the model at the center of the fifth floor and fig. 6b shows the measured data for the same point.

The results obtained thus far in this study represent the only known set of data available on a blast- and impedance-tested model and an impedance-tested prototype structure. The success obtained with this technique demonstrates that it is a valuable tool for use in predicting the blast-induced shock and vibration levels within structures.

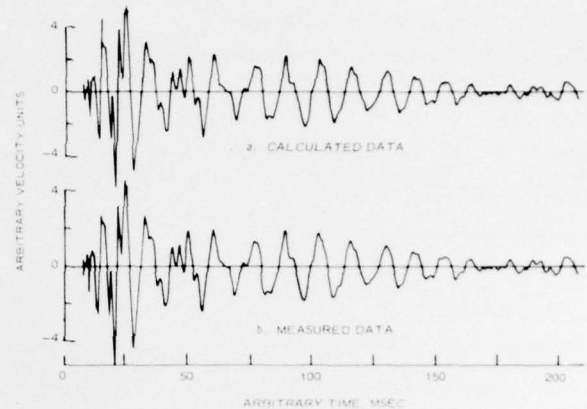


Fig. 6. Comparison of measured and calculated velocity data for the Dial Pack model

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COMPUTER-AIDED DESIGN,

by B. J. Brown,
Hydraulics Laboratory

The U. S. Army Corps of Engineers installed its first computer in the late 1950's. Today, the computer is used in some manner in a great number of Corps functions. It is considered to be an essential engineering tool by many Corps engineers and it now appears that the Corps is standing on the threshold of great promise for making the computer the indispensable engineering tool it is capable of becoming. The principal factor for this potential has been the development of the time-sharing computer system.

The development of a meaningful computer potential within the Corps of Engineers began in 1965 when the Office, Chief of Engineers (OCE), began with an in-depth study of the engineering processes and the identification of problems associated with computerizing these processes. In reviewing the problems, OCE grouped them into three principal areas: (1) a need to provide better and more easily accessible hardware; (2) a need to develop a library of computer programs pertinent to the Corps of Engineers mission and which could be relied upon to produce satisfactory solutions; and (3) a need to make it easier for the engineer to communicate with and use the computer.

The U. S. Army Engineer Waterways Experiment Station (WES), in conjunction with OCE, has addressed these problems and there is now a pilot system operational

in the time-share mode on the WES computer. The Conversationally Oriented Engineering Computer System allows an engineer to use any program or group of programs from a subroutine library with an absolute minimum of effort. The system communicates with the user in his own language and produces results that he can understand. Presently the library contains over 35 programs related to hydraulic engineering. Other disciplines will be included when programs are developed. The name of the executive program is CORPS*** (an acronym for Conversationally Oriented Real-Time Program Generating System). The three asterisks denote that the program is in the WES computer system library and available to all users of the WES time-sharing system.

The mechanics for using the system are quite elementary. The engineer accesses the WES computer via a time-sharing computer terminal. He converses with the computer in English, types in which programs he wishes to run, supplies the inputs demanded by the computer, and reviews the results as printed at the terminal. The entire process can easily be learned by an engineer in just a few minutes. Since the basic subroutines now in the system were developed by hydraulic engineers, they are written in the language of an engineer. New hydraulic design programs are continuously being added to the system as time permits. The only requirement for adding new programs to the system is that each program contain a preamble conforming to system specifications.

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